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EVALUATION AND PLANNING FOR DISTRIBUTION OF EDUCATIONAL PROGRAMMING IN KOREA

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EVALUATION AND PLANNING FOR DISTRIBUTION OF EDUCATIONAL PROGRAMMING IN KOREA

A. SUMMARY AND RECOMMENDATIONS

The Communication Satellite Planning Center of Stanford University has reviewed the alternatives available to the Korean Educational Development Institute (KEDI) to achieve national television distribution to Korea's schools. The alternatives considered were:

1. continue development of the TCOM balloon system,
2. switch to a communication satellite system based on the use of the INTELSAT IV satellite, and
3. use the Ministry of Communications (MOC) microwave network and Korean Broadcasting System (KBS) transmitting facilities.

It is strongly recommended that KEDI use the third alternative for the next two years, e.g., the microwave network and KBS transmitters. The KBS network can provide immediate access to television broadcast during school hours (KBS does not broadcast until 6 p.m.). The network currently covers 72% of the population and in two years will be expanded to over 90%. KEDI's use will add very little to the cost of KBS's own operation. With national distribution, KEDI's use of the microwave network of MOC will amount to about $180,000 per year.

It is strongly recommended that KEDI not rely on the TCOM balloon system to transmit television to Korea's schools. Despite assurances of coverage up to 130 miles from the balloon, TCOM does not provide effective coverage beyond 40 or 50 miles. Beyond that distance, signals are increasingly blocked by mountains, hills, and nearby structures. Less than 1/4 of Korea's schools can see the balloon. Even if the balloon can be made to work reliably, the cost of many repeater stations needed to complete coverage, plus the balloon, far exceeds other alternatives. And the schools to the north and to the south will still be uncovered.

For KEDI operations beyond one or two years, a national TV channel separate from KBS is desired. For this service, two alternatives should be considered. First is rental of channels from the national MOC microwave network plus addition of second channels at the transmitter sites of KBS. The second is rental of a TV channel from the INTELSAT IV satellite and reception at low-cost stations around Korea. These signals would then be transmitted by local stations and retransmitted by mountain-top repeaters, most located with KBS's current system. Current indications are that the satellite would be more expensive by about 20%. However, the cost comparison will depend on detailed evaluation and pricing policy of MOC and INTELSAT IV. Either of these alternatives is much less than half the cost of national coverage by a TCOM balloon network.

It is recommended that KEDI start at once with the KBS network to get television to the schools. An initial research phase could use only the KBS Seoul Station and associated repeater sites; this covers KOREA's northwestern area without needing to rent any capacity on the national microwave network. Meanwhile, a more detailed implementation plan and fixed price information s ould be obtained for an independent national channel via either satellite or ground microwave plus television transmitters.

B. USE OF THE KOREAN BROADCASTING SYSTEM FACILITIES

1. The KBS System

The Korean Broadcasting System (KBS) facilities cover much of Korea. Signals are originated at Seoul and a national microwave network, operated by the Ministry of Communications (MOC), carries signals to 11 other cities. At Seoul and these cities the signals are transmitted on VHF television. In addition, signals from those transmitters are received by distant mountain-top "translators" which transmit the signals on different TV channels to cover remote communities (see Fig. 1).

Currently, the transmitters and translators cover 72% of Korea's population. In the next two years, ten of the transmitters are to be increased in power and fifty additional translators will be added. With these additions, the KBS signals are expected to cover over 90% of the population.

The KBS rental of capacity on MOC's national microwave network costs $200 per hour. Last year, their total rental amounted to $548,000.

The number and power levels of KBS's current transmitters are shown in Table 1. In the expansion plans most of the new translators will be from one to 50 watts power level. Table 2 gives a typical cost breakdown for repeater installations and the cost of adding a second transmitter to an existing site. Table 3 gives typical costs for higher power transmitter installations.

KBS uses its transmitting facilities only after 6 p.m. in order to reduce the consumption of electricity by the country's 2,500,000 TV sets. For school broadcasts, this consumption of electricity will not create a problem since far fewer sets will be turned on, and so KEDI programs can be broadcast during the day.

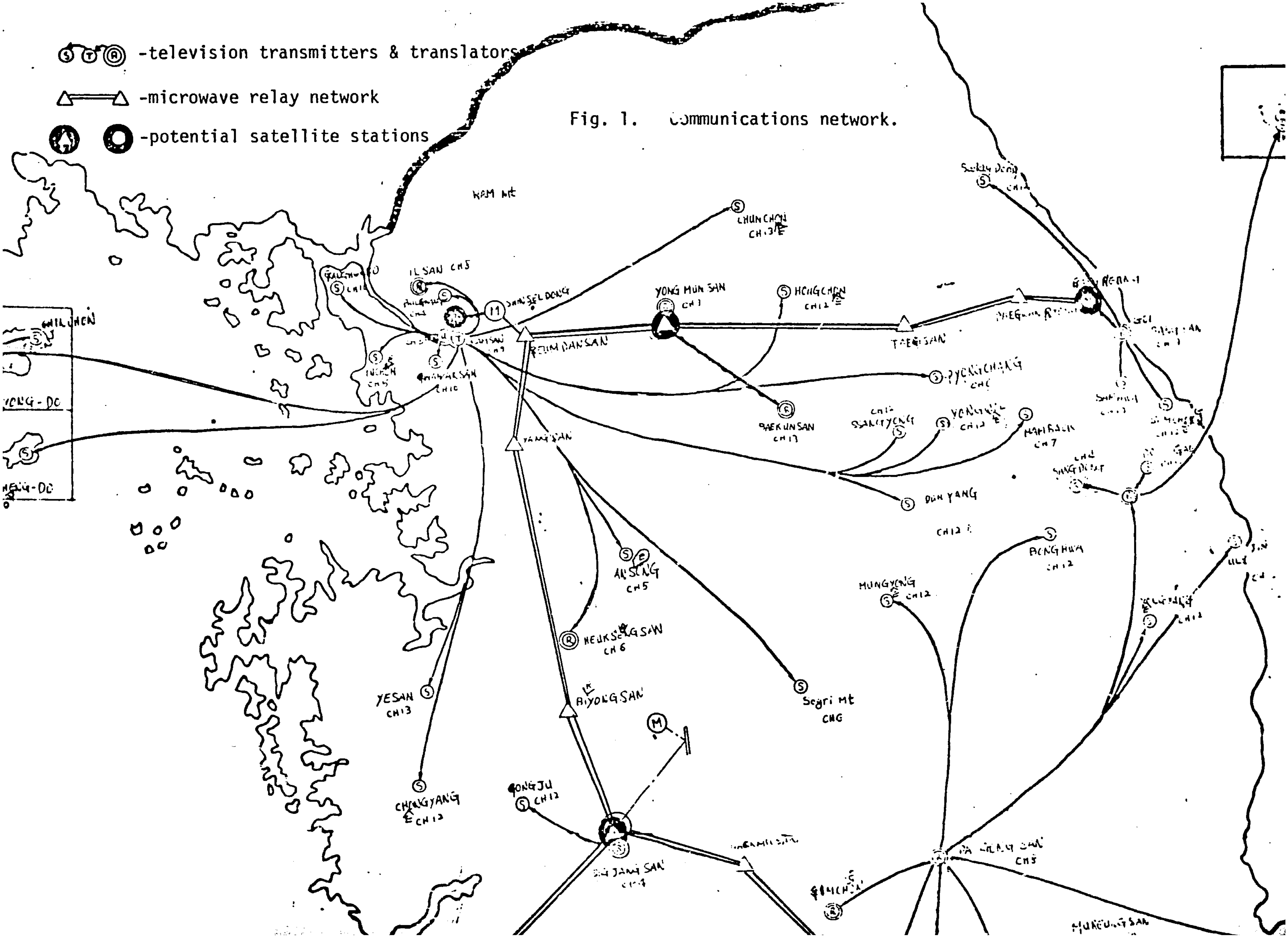


Fig. 1. Communications network.

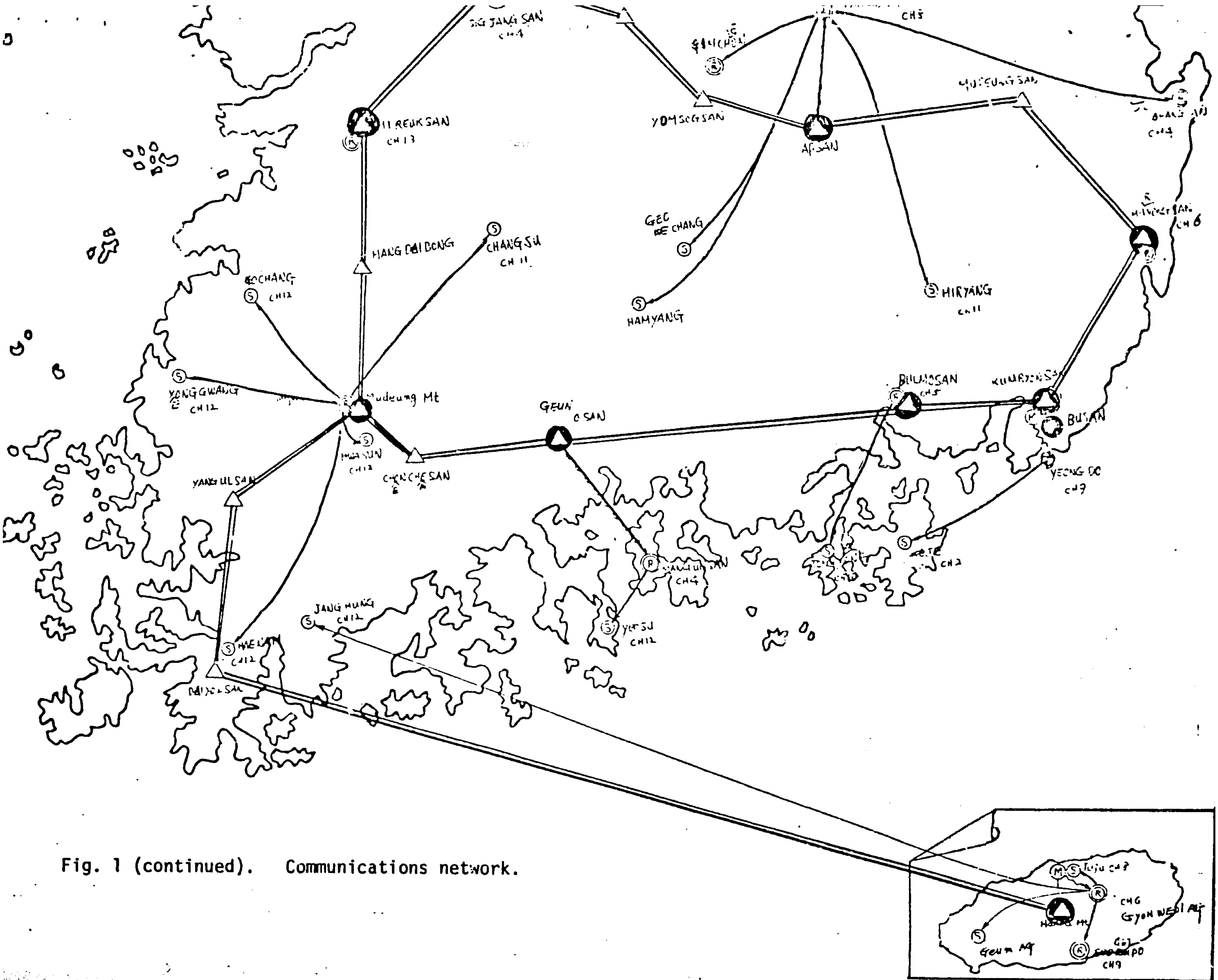


Fig. 1 (continued). Communications network.

TABLE I

KBS Transmitter Power Levels

Power Levels (Watts)	Number Transmitters
50,000	1
10,000	3
5,000	1
2,000	5
1,000	1
500	5
300	1
100	3
50	2
30	1
10	19
1	20
TOTAL	62

TABLE 2

Typical Costs of KBS Translator Sites

	100 Watts	10 Watts	1 Watt
Civil Work	$100	*	*
Building	$2,700	*	*
Fence	$1,200	*	*
Towers	$3,400	*	*
Electronics	$27,160	$22,160	$15,160
Installation	$6,400	*	*
Power Line	$8,000	*	*
TOTAL	$48,960	$37,000	$30,000
<u>To add second Repeater</u>			
Modify tower	$3,400	$3,400	$3,400
Transmitter	$27,160	$18,000	$15,000
Installation	$6,400	$6,400	$6,400
TOTAL	$36,960	$27,800	$24,800

* Cost varies with type of components used, etc., but totals shown should be reasonably accurate although no allowance for inflation has been made. We estimate the cost for these items at $14,840.

TABLE 3

Typical Costs of High Power Transmitters

Power	Frequency	Cost
1 kW	U or V	$52,650
2.5 kW	V	$61,350
10 kW	U	$300,000
15 kW	V	$175,000
30 kW	V	$362,500
30 kW	U	$313,500
50 kW	V	$427,000
50 kW	U	$350,000

2. KEDI Experimental Phase

It would be possible during an initial testing phase, as soon as programs are ready, for KEDI to broadcast a limited schedule through the KBS Seoul transmitter. This will fully cover the Seoul area and communities in the areas of the translator stations using Seoul's signals. These include cities throughout the northern half of the nation. The signals would provide initial field tests for KEDI's programs in sample schools, signals to check out television sets being installed for beginning of full-scale operations later, and signals to compare and contrast with TCOM coverage.

During this period, the cost to KEDI would be small. The cost of the extra hours of operation of KBS's Seoul transmitter and associated repeaters is small and it is presumed that part of KBS's national responsibility includes educational broadcasts. No microwave facilities would be rented from MOC. KEDI's direct costs would be for a microwave link between KEDI studios and the Nam San Tower, about $15,000 to $20,000.

3. National Coverage with KBS Channels

The period of nationwide broadcasting, assumed to start in late 1977, would be more costly. It is assumed that KBS transmitter operation itself would be covered by KBS (the additional cost for KEDI's daytime use is small). However, the additional rental of the national microwave network from MOC would cost approximately $200 per hour. For three hours per day of broadcasting this would add to 800 or 900 hours per year or about $180,000 per year. This cost may have to be borne by KEDI; it depends on national policy since KEDI, KBS, and MOC are all government institutions.

4. Independent KEDI Channel Using KBS Sites

While daytime hours of the KBS system can be used at first, inevitably scheduling will become crowded and thus an independent KEDI channel will become desirable. To accomplish this with the current system, the simplest approach would be to add a second channel to the existing towers and translator sites used by KBS. In addition, KEDI would rent a channel from the MOC microwave distribution network. Initial information indicates that the expanded capacity of the MOC network will be adequate and most sites will be able to add second transmitters with little difficulty.

The cost of a second network must be estimated in detail; however, an initial rough estimate is possible. The microwave rental will depend on the hours of yearly broadcast. Table 4 shows the annual costs for different average hours of daily broadcasting. This presumes a constant rental policy

TABLE 4

Annual Costs of National Microwave System

Average hours per day including holidays	Annual rental at $200 per hour
3	$220,000
6	$440,000
12	$880,000
18	$1,580,000
24	$1,750,000

by MOC. The rental runs from $220,000 to $1,750,000 per year.

The costs for the extra transmitter and translator sites can be estimated roughly from the costs of the KBS sites. The KBS engineering staff indicate that it would cost between $25,000 and $37,000 to add a channel to an existing translator site, depending on the power. These costs are for fully redundant automatic systems, including a battery system for a week's operation in case of local power failure. The costs of higher power main transmitters are estimated in Table 3.

For 72% population coverage, KEDI's capital cost would be about $3,000,000, about half going to city transmitters and half to remote translators. To reach 75% coverage with an added 50 translators will add about $1,500,000 in costs.

Maintenance of this system will be about $100,000 to $300,000 per year, depending on labor costs and combined maintenance operation with KBS.

Thus, an independent nationwide KEDI channel will cost from $3 million to $4.6 million in capital expenditures. About one-half of this equipment consists of the lower power translators, and it may be manufactured in Korea. The annual maintenance and operation plus rental of microwave facilities will run from $1,000,000 to $2,000,000 per year, depending on hours of daily broadcast and maintenance strategy.

C. COVERAGE OF THE TCOM BALLOON SYSTEM

The TCOM balloon system was intended to provide coverage to a high percentage of Korea's schools at a capital cost between $7 million and $8 million and an operations cost of $200,000 to $300,000 per year. The balloon system transmits from an altitude of 10,000 feet over Korea's central mountain range.

While initial coverage to a range of 132 miles was anticipated, in actual operation coverage directly from the balloon can be expected to reach only 40 to 50 miles. Beyond this range, mountains block the signals to many schools and extensive use of television translator-transmitters will have to be made to provide reliable coverage to the schools.

The difficulty can be seen in Figures 2 through 5. These figures show typical mountain profiles in Korea drawn on a line from the TCOM balloon to different parts of Korea. (The vertical distance is expanded to allow easier measurement of viewing angles.) The straight lines are drawn to show lines of sight to the TCOM balloon. Figures 2 and 3 show profiles toward Seoul; Figure 3 is more typical than Fig. 2. As can be seen, there are many areas in these profiles where the populated valleys cannot see the balloon. Figure 4 shows a typical profile towards Korea's East Coast. The heavily populated coastal area is completely blocked by the mountain range between TCOM and the coast. Figure 5 shows a typical profile from TCOM towards the south; again the mountains cause much blockage beyond 40 miles.

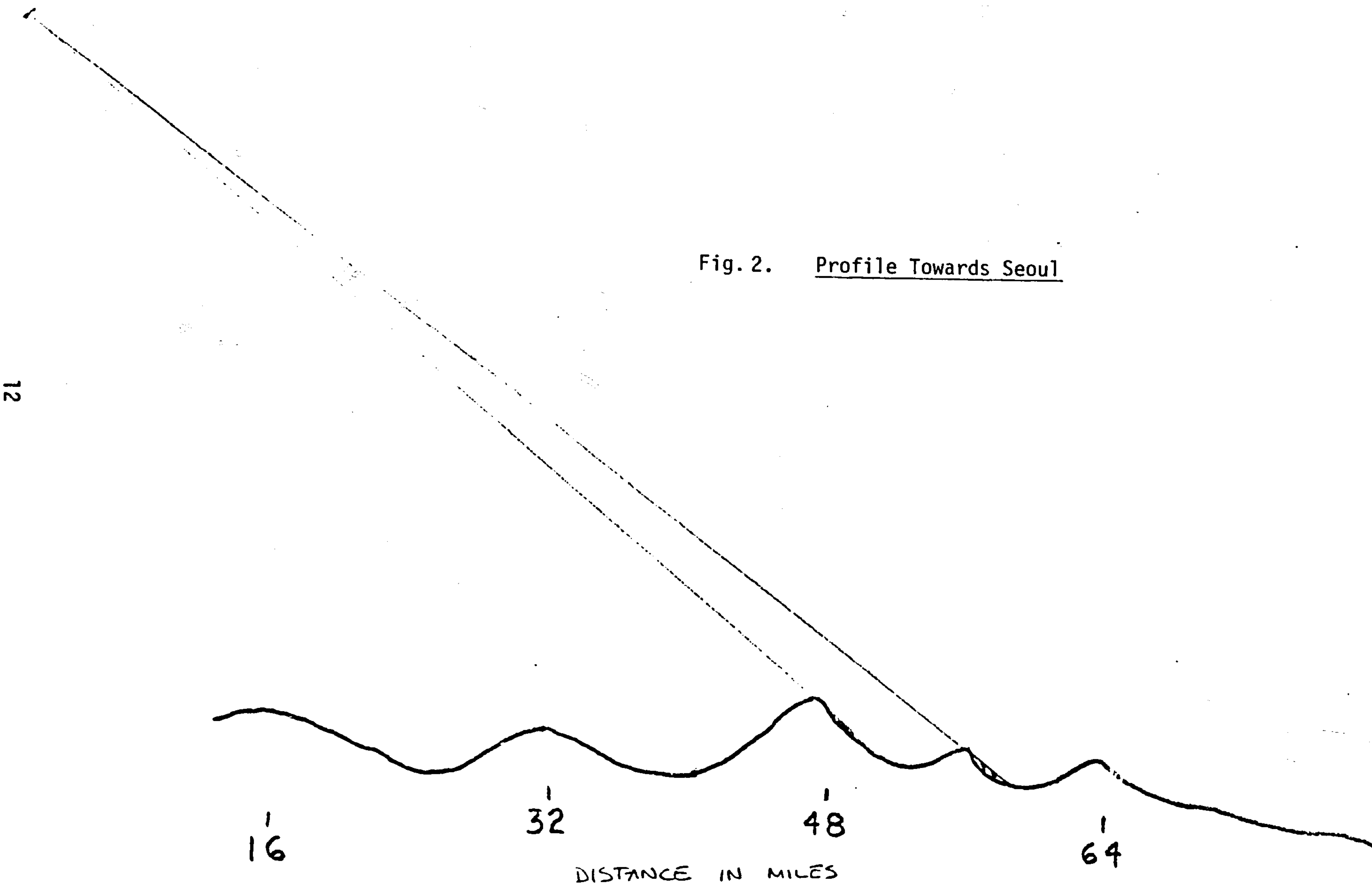


Fig. 2. Profile Towards Seoul

Fig. 3. Profile Towards Seoul

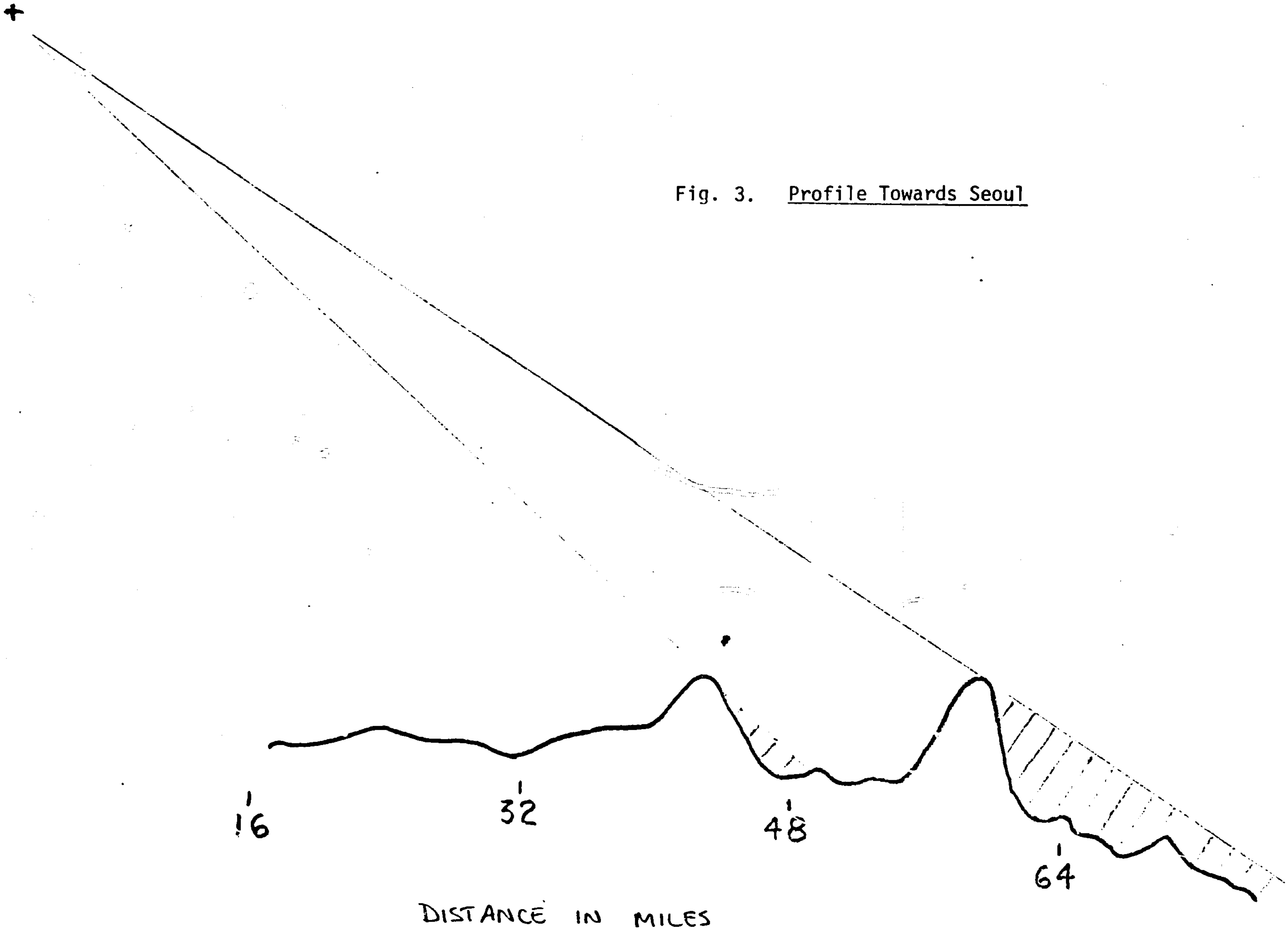


Fig. 4. <u>Typical East Coast</u>

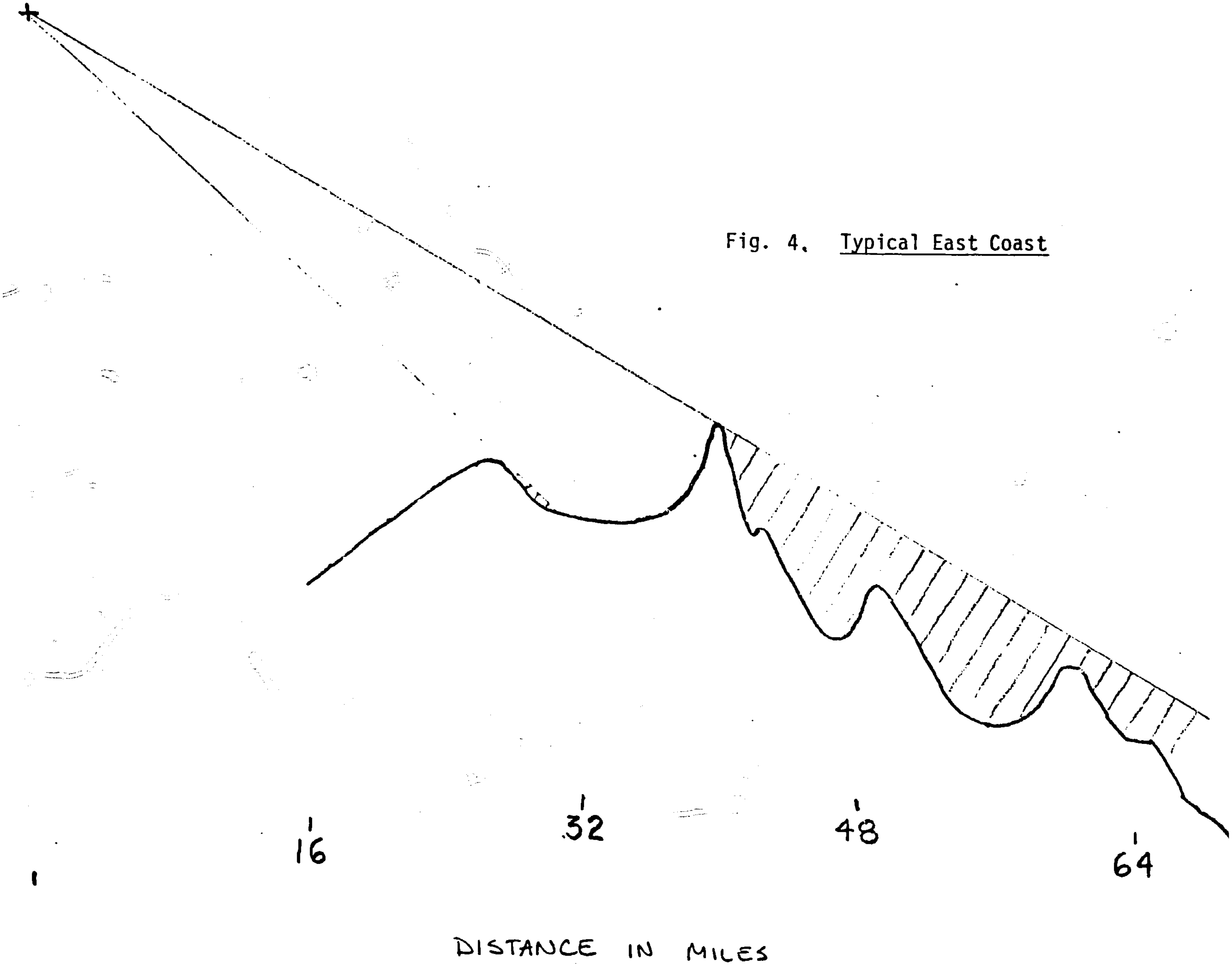
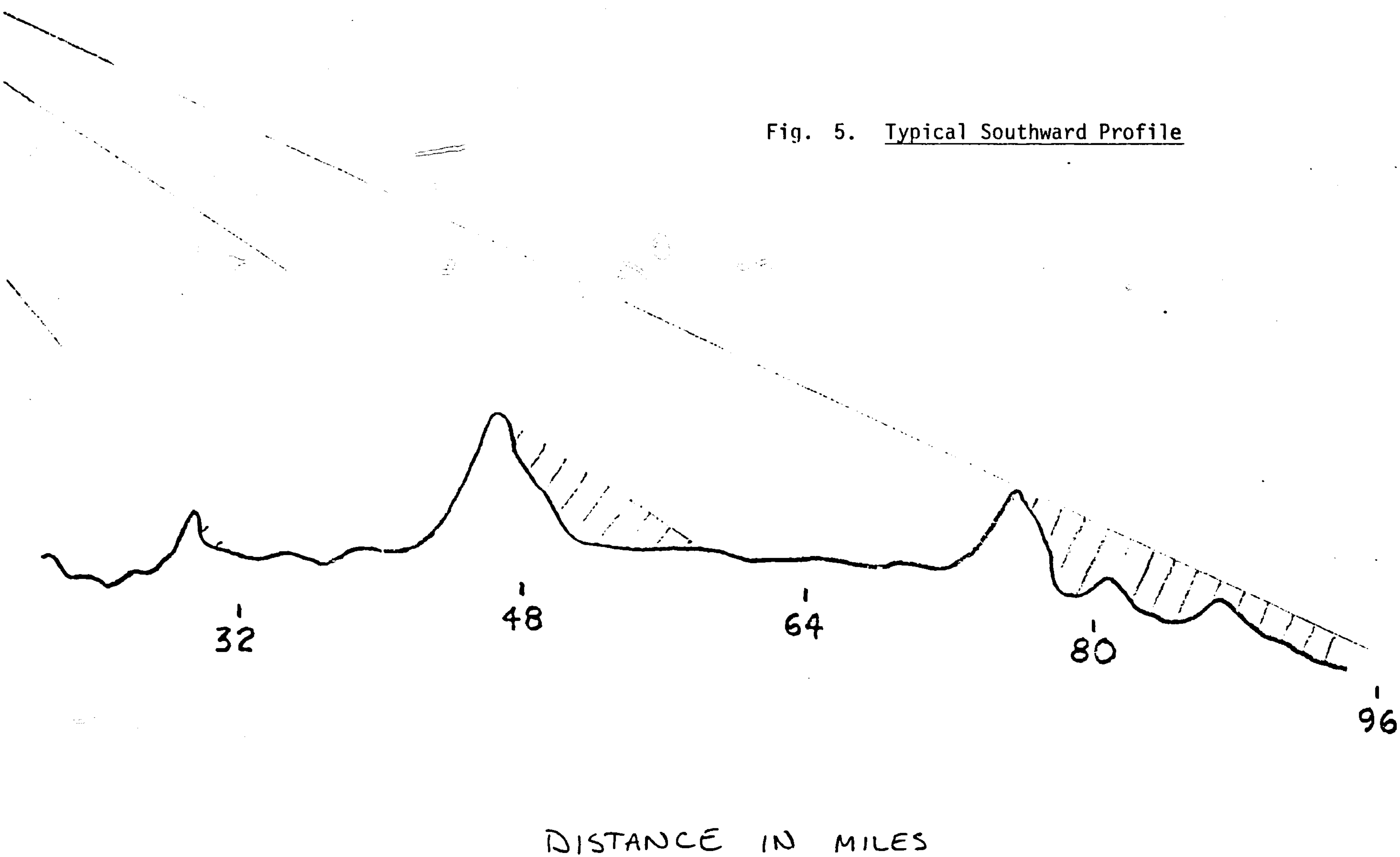


Fig. 5. Typical Southward Profile



Thirteen profiles were analyzed to obtain an estimate of the percentage coverage of the populated valleys at different distances from the balloon. Up to 40 miles from TCOM about 95% of the area was covered. Between 40 and 60 miles only 50% of valley areas are covered. Between 60 and 90 miles about 17% are covered. Beyond 90 miles, less than 5% is covered. KEDI's Technical Support Bureau is carrying out a detailed profile survey that can be expected to confirm these estimates. A photographic method to obtain coverage patterns more quickly is described in Appendix A.

When these percentage coverages are used with the number of schools at each range, an estimate of the schools covered can be made. The initial estimate is that about one quarter of the school population is all that is covered. This figure actually is very optimistic, since additional blockage by nearby hills and large buildings has not been accounted for. Such blockage may reduce the schools covered beyond 50 miles by an additional 30% to 50%.

Because the blockage beyond 40 or 50 miles approaches 50% and occurs in irregular patches in the valleys, repeaters will have to be used beyond this distance to get reliable coverage. Figure 1 shows a map of the repeater and transmitter sites KBS has found necessary for 72% coverage of Korea. TCOM eliminates the need for translators covering only the central area (Fig. 6). There are only four to six translators that could be eliminated without leaving many schools uncovered.

If KEDI's goals are to provide a high percentage coverage of Korea's schools, almost all of the transmitters and repeaters estimated in Section 2 will still be needed. Only five or six low-power repeaters will be saved, with a cost saving of about $180,000. It will also still be necessary to use the microwave network to cover locations in the north and south areas of the country.

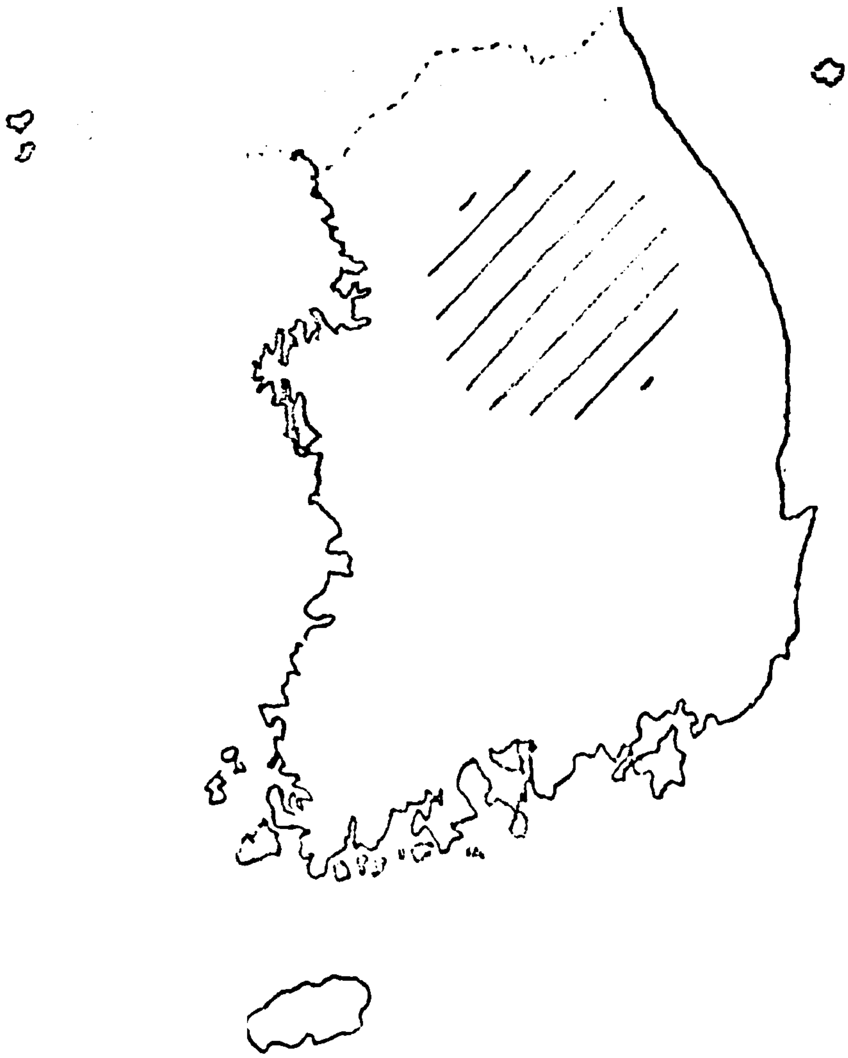


Fig. 6. Expected Reliable Coverage of TCOM

To obtain any reasonable coverage of the schools in the rest of the country through balloons it will take not one but rather three or four more balloons; and this would still leave many shadow areas uncovered. Since the price of a single balloon is far greater than the price of a nationwide KEDI network based on ground microwave and transmitters, there seems to be little incentive for KEDI to consider TCOM in their future plans.

D. FEASIBILITY OF A SATELLITE DISTRIBUTION SYSTEM USING THE INTELSAT IV AND ITS SPOT BEAM

1. The INTELSAT IV Satellite

The INTELSAT IV satellite, presently in synchronous orbit at 174° east longitude over the western Pacific Ocean, is being used by member countries in the INTELSAT organization for international telephony communications. This satellite is equipped with both a global beam for complete coverage of the hemisphere within the view of the spacecraft and with two spot beams capable of illuminating a four and one-half degree circle at virtually any location visible to the satellite in that hemisphere. This spot beam concentrates the energy from the spacecraft transmitter into a smaller region and thereby increases the total power available for communication services within that region. This increase in power permits a corresponding decrease in the size and complexity of earth station receiving equipment with a commensurate savings in cost. Presently, none of the INTELSAT member nations are using the spot beam capability, nor is the satellite being used to its full capacity. That is, there are unused transponders on board. Because of recent advances in both technology and market development in the area of domestic satellite communications, it is now feasible to use the spot beam on INTELSAT IV to transmit high quality video programming to comparatively unsophisticated earth stations whose costs are now on the order of $40,000 each, installed, in very small quantities. In addition, the annual cost for the transponder lease is estimated at approximately $2 million per year for a fully backed up transponder. If 100% redundancy is not required, the cost could be as low as $1 million.

2. Video Quality Requirements

Since the INTELSAT IV spacecraft has a fixed amount of power, it would require large and expensive earth stations (such as INTELSAT standards) to obtain highest quality (50 dB) video signal to weighted RMS noise ratio. We, therefore, recommend that a nominal video signal-to-noise ratio (SNR) of 44 dB (still TASO-1 quality) be used as a system performance goal. This signal is of excellent quality for use at the point of reception and permits the use of small economical earth stations requiring only a 4.57-m antenna and a simple transistorized low-noise preamplifier. For rebroadcasting the video signal from the earth station to other locations, the signal quality should be 50 dB SNR. This quality can be obtained by using a specific INTELSAT IV transponder with the highest power and a lower noise temperature preamplifier. Table 5 gives the characteristics of the INTELSAT IV satellite while Table 6 gives the EIRP's for its global and spot beams.

The earth station parameters are determined by the available EIRP and the desired signal quality, taking into account the link margins. For the link calculations presented here, the minimum published EIRP (Table 6) at 1 dB contour is used, but it is worthwhile to note that there are many transponders available with greater power. We have also included adequate

TABLE 5

INTELSAT IV Characteristics

ANTENNA :	
Type	: Global receive, global transmit : conical horn with flat plate reflection. Spot beam : 127 cm parabolic reflector*. Omnidirectional command receive antenna and omnidirectional telemetry transmit.
Number	: 2 of each of the above communications antennas.
Transmit beamwidth	: global : 17°, spot beam : 4.5°
Transmit gain	: global : 20.5 dB, spot beam : 31.7 dB
Polarization	: circular
REPEATER :	
Frequency band	: C band, receive global : 5932 to 6418 MHz transmit global: 3707 to 4193 MHz transmit spot beam : 3707 to 4033 MHz
Type	: Linear or limiting** single RF conversion repeater.
Bandwidth (-1 dB)	: 36 MHz per channel
Number	: 12
Receiver front end type	: Tunnel diode amplifier
Receiver front end gain	: 13.8 dB
RCVR system noise figure	: 8.2 dB (T_{system} = 1626°K)
Transmitter type	: TWTA
Transmitter gain	: 58 dB
Transmitter power output	: 6 watts per transponder
GENERAL :	
EIRP***	: global beam : 22.5 dBW per transponder at beam edge
	: spot beam : 34.2 dBW per transponder at beam edge
Receive G/T	: -17.6 dB/°K over $\pm$ 8.5 degrees
Channel gain	: adjusted by command
Communication system power needs : 310 watts	

*Steerable spot beams by command

**Selectable by ground command

***Measured in anechoic chamber

TABLE 6

EIRP's for the INTELSAT IV F-3 Global Beam and Spot Beam

Channel	Global Beam Peak	Global Minimum Beam Edge	EIRP Spot Beam Center
1_B^A	26.8 26.6	23.5 23.3	38.3 38.1
2_B^A	26.7 27.0	23.5 23.8	38.2 38.5
3_B^A	26.7 26.8	23.1 23.2	38.2 38.3
4_B^A	27.1 27.1	23.7 23.7	38.6 38.6
5_B^A	26.9 26.8	23.1 23.0	38.4 38.3
6_B^A	27.0 26.9	23.4 23.3	38.5 38.4
7_B^A	27.0 27.0	23.0 23.0	38.5 38.5
8_B^A	27.3 27.1	23.5 23.3	38.8 38.6
9_B^A	26.8 26.8	22.7 22.7	38.3 38.3
10_B^A	26.9 27.2	23.0 23.3	38.4 38.7
11_B^A	27.1 27.0	23.0 23.0	38.6 38.5
12_B^A	27.3 27.3	23.3 23.3	38.8 38.8

margins for rain loss and pointing errors. Table 7 gives the results for a peak-to-peak weighted SNR of 44.2 dB, while Table 8 shows the link calculations for a carrier to noise ratio of 12 dB. The earth station G/T obtained is 19.7 dB, which can be optimally realized using a 4.57-m antenna with a 180°K low noise amplifier and a threshold extension video demodulator. The threshold extension video demodulator is necessary to insure that an adequate margin above threshold is maintained; this will guarantee a good signal quality for all types of weather conditions.

The earth station parameters recommended here represent an economical choice because these equipments are being used in the developing market in the United States for domestic satellite systems. The largest current user is the Alaskan domestic satellite system with 100 stations. The Satellite Business System 11/14 GHz network will be using 5-m antennas in the near future. Because of this growing need for equipment, the prices are continuing to drop.

An example of a typical earth station is shown in Fig. 7. These photographs were taken at Stanford University and are prototypes which have been delivered to Indonesia for use with their Palapa satellite for experimental communication purposes.

Typical cost figures for 20 stations are shown in Table 9. These figures are derived from experience and from direct cost quotes from vendors. The capital costs of the earth station hardware are based on recent discussions with vendors and on actual quotations. They are felt to be quite conservative.

TABLE 7

Television Signal-to-Noise Calculations

Noise bandwidth.	22.0 MHz
Modulation index β	1.49
f_m	4.2 MHz
Carson's Rule Bandwidth B	20.95 MHz
FM improvement: $3/2(\beta^2)\frac{BWrf}{f_m}$	14.6 dB
Noise weighting.	10.2 dB
Pre-emphasis	2.4 dB
rms to peak-to-peak conversion factor.	6.0 dB
Carrier-to-noise	12.0 dB
Less implementation loss	-1.0 dB
Peak-to-peak weighted S/N.	44.2 dB

TABLE 8

Television Link Calculations for Korean Demonstration with INTELSAT IV

PARAMETER	
Satellite EIRP, Spot Beam Center	38.2 dB
Beam Edge Loss, 1 dB Contour	1.0 dB
Path Loss	196.4 dB
Rain Attenuation	1.0 dB
Uplink Contribution	0.6 dB
Pointing Error & Atmosphere Absorption	0.8 dB
Earth Station G/T	19.7 dB
Degradation in G/T from Rain Loss	1.3 dB
Noise Bandwidth (22 MHz)	73.4 dB
Boltzman's Constant	-228.6 dBW
Carrier-to-Noise Ratio	12.0 dB

3. Application Procedure for Use of INTELSAT IV

The procedure for obtaining the use of INTELSAT IV is through a formal request to the Board of Governors of the INTELSAT organization by the appropriate government agency of Korea. This request must specify the use of INTELSAT IV spot beam and an available transponder, and request a quotation for a tariff for leasing the transponder. Generally, the period of time quoted is for five years, but a different length of time may be requested according to needs.

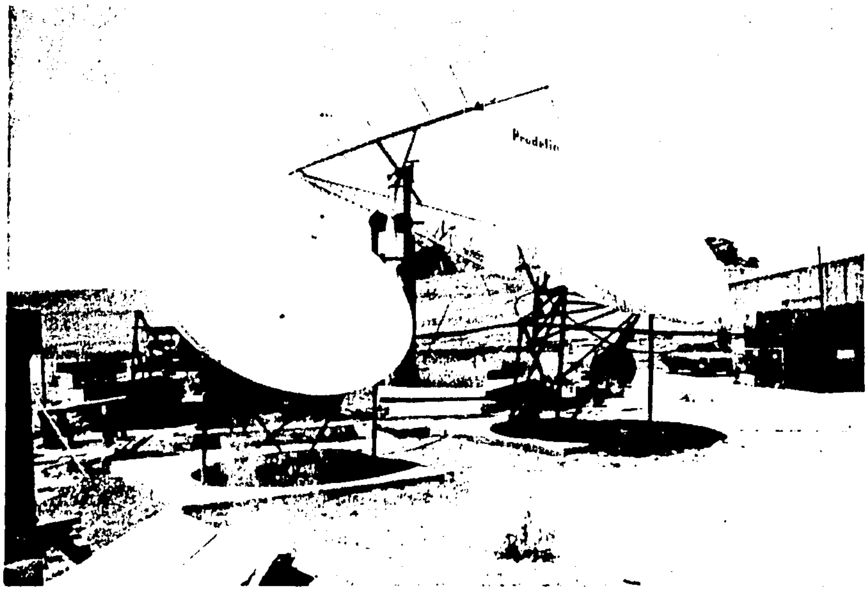


Fig. 7A Three-meter and 4.57-meter antennas installed for testing at Stanford University field site.

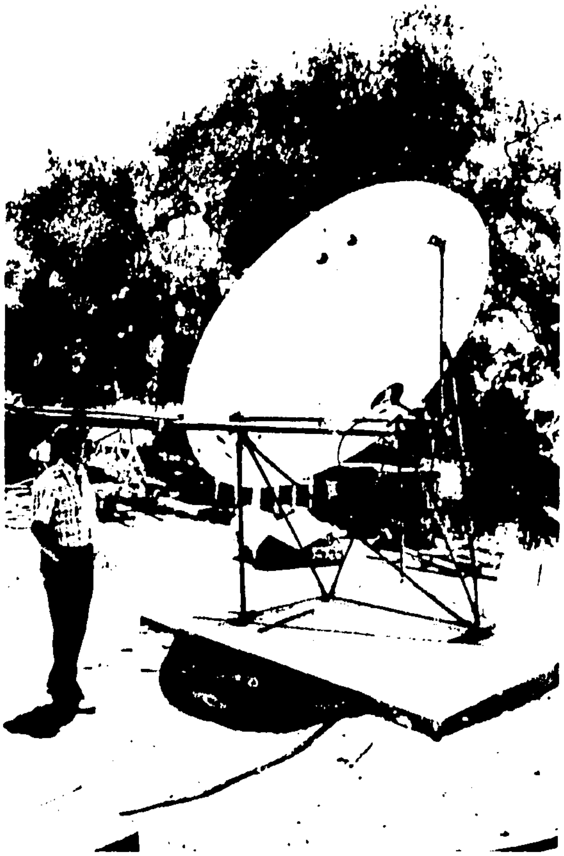


Fig. 7B Rear view of 3-meter antenna and mounting system.

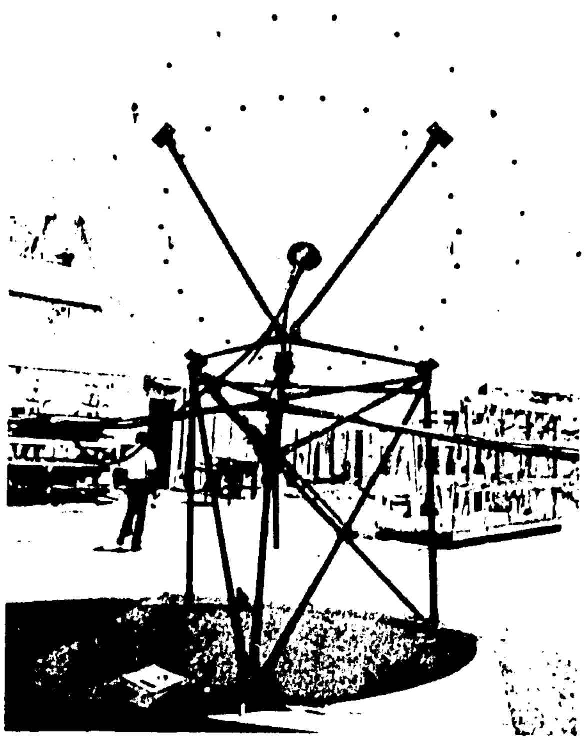


Fig. 7C Rear view of 4.57-meter antenna and mounting system.

TABLE 9

Earth Station Costs

Capital Cost for Equipment	U.S. Dollars
Antenna (4.57-m, Prodelin or Andrew Companies)	$10,000
Low-noise amplifier (180°K, Amplica Co.)	$2,800
Threshold extension video demodulator and downconverter (Calif. Microwave, Inc.)	$8,950
	$21,750
Procurement, integration, overhead (30%)	$6,525
	$28,275
Shipping cost	$2,000
Site preparation	$3,000
Installation	$3,000
	$36,525
Management fee (15%)	$5,475
TOTAL PER STATION COST	$42,000
Total for 11 stations	$462,000
Uplink Transmitting Earth Station	$250,000

Notes: Standard video demodulator and down converter without threshold extension cost quotation from Farinon Video is $7,950. The extra $1,000 buys 3 dB of additional margin against signal fades and noise from threshold effects. This cost estimate is for 20 stations; the per station cost could increase to $50,000 each, for quantities from two to ten.

4. Application of the INTELSAT IV Capability

This capability could be used in a number of ways. Ground stations could be located at major educational institutions and provide them directly with closed circuit TV. For KEDI's application, the need to cover most elementary and middle schools precludes this use. Ground stations could be located at each transmitter and translator site, providing signals for rebroadcast to conventional sets. Or ground stations could be located only at primary transmitter sites, assuming the signals transmitted from primary transmitters will be received at remote translators and transmitted to the nearby communities. The satellite is best used with a combination of these last two ways.

If the satellite ground stations are located at the eleven main transmitting sites of the KBS network, they will eliminate the need for rental of the microwave network. Signals from these transmitters would be received at the remote translators.

With this use of the satellite, the same number of transmitters are required as in the case in Section B of this paper. What is saved is the rental of the microwave network.

The transmitting station and the eleven receiving stations will cost about $700,000. In addition, the satellite channel will rent for $1,000,000 to $1,500,000 per year. This is to be compared with rental of the microwave network, which will vary between $220,000 and $1,750,000 per year, depending on the hours of use each day.

For a full national network, KEDI would still need the transmitters which will cost from $3 million to $4.5 million, depending on whether 72% or over 90% coverage is achieved.

The cost of national coverage with the satellite distribution may be somewhat more than with microwave distribution, but both systems will be much less costly than distribution with the TCOM balloon.

The main advantage with the satellite is that areas not reachable by either the microwave or mountain top translators can be reached at small extra cost.

E. ACKNOWLEDGEMENTS

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APPENDIX A

APPENDIX A

PHOTOGRAPHIC COVERAGE SURVEY

To determine the area of Korea covered by the TCOM balloon, a photographic survey technique has been developed. Basically, a projector shines light on a three-dimensional contour map at an angle that is the same angle that the TCOM balloon would illuminate the area. The shadows of the mountains then represent the areas that would not receive line-of-sight signals from TCOM (see Fig. 1).

In this method, three factors must be accounted for in setting the angle that the light illuminates the map. First, the curvature of the earth reduces the apparent illumination angle as the distance from TCOM increases. The angle at 40 miles is different from the angle at 60 miles, both because of the distance and the curvature of the earth. For a given angle, the shadow map is accurate only over a distance span of about 15 to 20 miles. Beyond this distance, the light angle must be changed and another picture taken.

Second, because light originates from the projector at a greater distance than the apparent distance from the balloon, the shadows are somewhat smaller than in the actual system (see Fig. 2). Beyond a distance of 40 miles from TCOM this effect is small if the pictures cover only a 15 to 20 square mile area. Within 40 miles a second technique is used. The light is placed above the three-dimensional contour map at the apparent altitude of the balloon and the shadows photographed from above (see Fig. 3).

Third, the contour map uses a vertical height exaggeration of three to one, i.e., in scale, the mountains are three times steeper than in

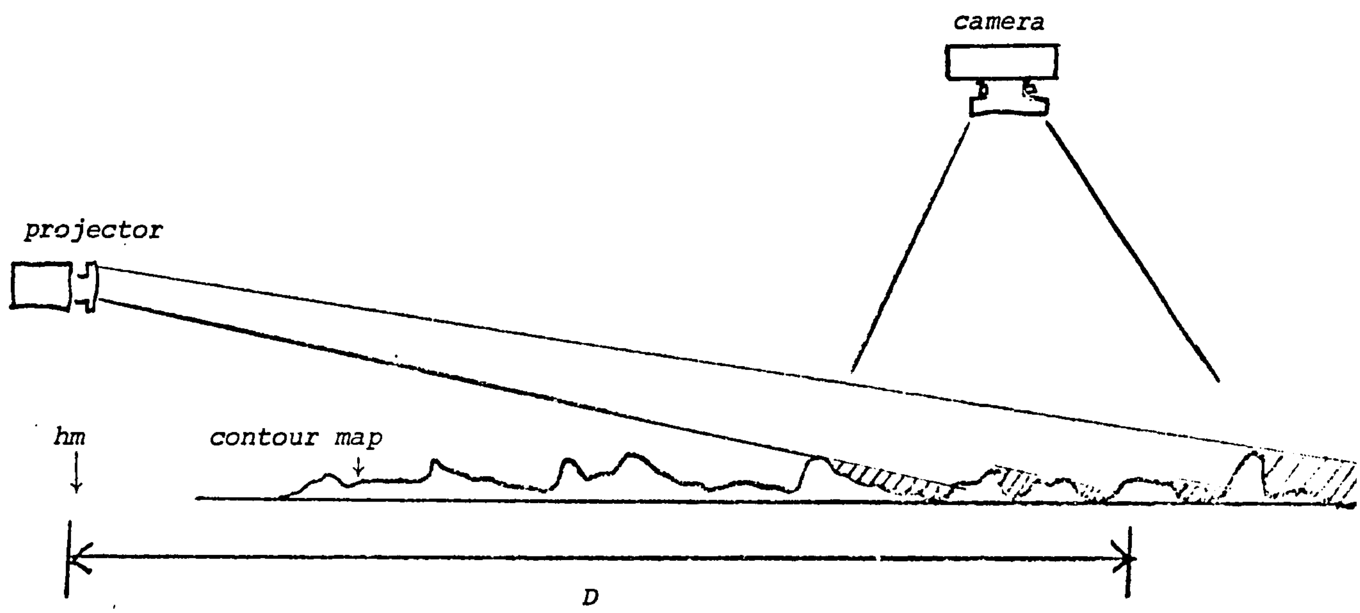

Fig. 1 PHOTOGRAPHIC TECHNIQUE

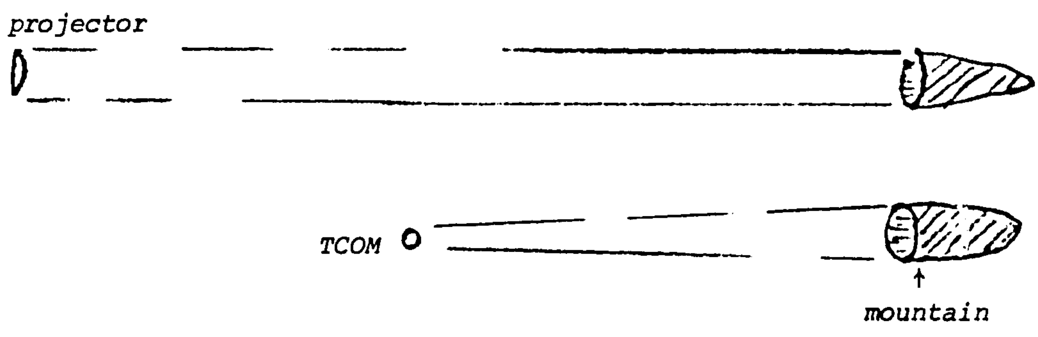

Fig. 2 ERROR IN SHADOW SIZE

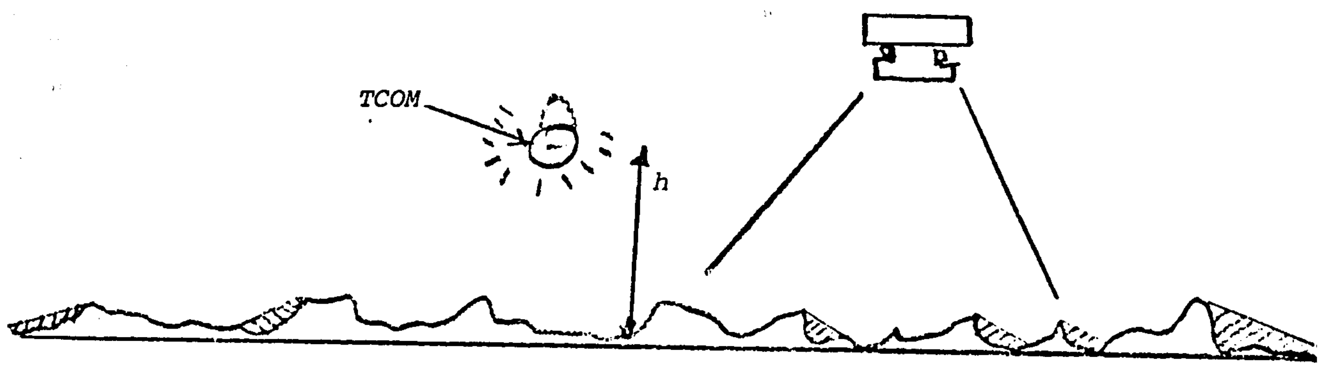

Fig. 3 PHOTOGRAPHIC TECHNIQUE NEAR TCOM

reality. The altitude of the balloon, the angle of illumination and the corrections for curvature must account for this exaggeration.

The photographs made, and left with Dr. Lee in Korea, have accounted for these effects. While a complete photographic survey is contemplated using this technique, initial observations can be made with photographs taken in initial work. Figure 4, a photograph taken using the technique shown in Fig. 3, shows the area fairly close to the balloon. Good coverage is obtained at short range (upper left corner). At a moderate distance the very rugged terrain, typical of central Korea, begins to cause a great deal of shadowing in the valleys between the mountains.

Figure 5, a photograph taken using the technique shown in Fig. 1, shows an area along the northeastern coast. The shadows (edges indicated by the arrows) show that there is practically no coverage of the coastal communities. The nearby mountain ranges block the TCOM signals. This shadowing is representative of the profile shown in Fig. 3 on page 12 of the attached report entitled "Evaluation and Planning for Distribution of Educational Programming in Korea."

Figure 6 shows an area of northwest Korea. The less mountainous area has better coverage. But because TCOM is at a great distance, even fairly small mountains cast long shadow areas.

The photographic technique is a fairly quick way to define the areas of Korea where TCOM's coverage will be problematical. The observations from the first set of photographs confirm the estimates made by the profile techniques. It is recommended that a complete survey, using the contour map available at KEDI, be made to provide a guide to the actual coverage measurements that will be made when the balloon is again tested.

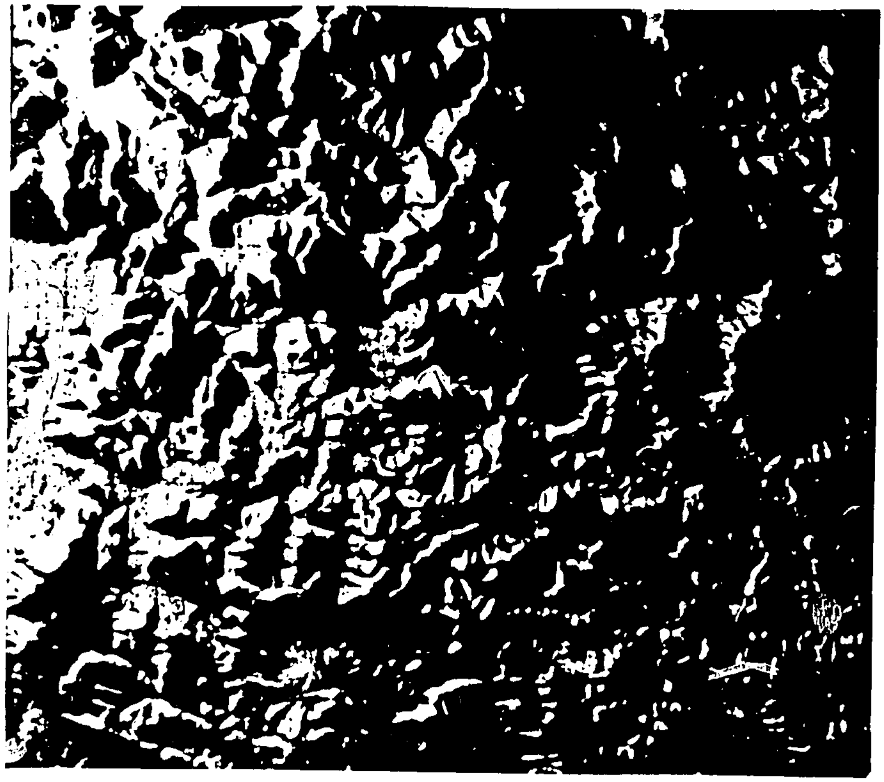

Fig. 4. Area near TCOM showing shadows in mountain valleys.

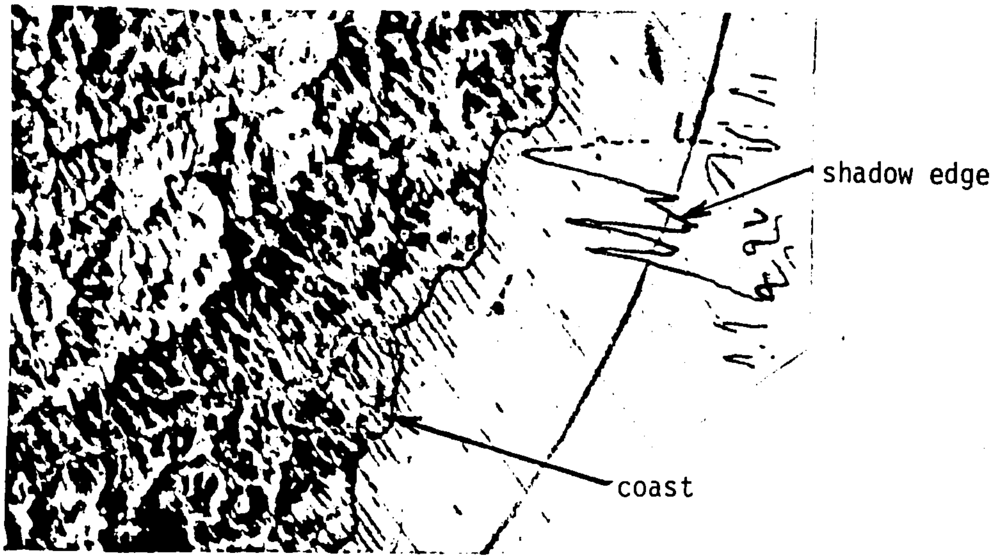

Fig. 5. Northeast coast.

Fig. 6. Northwest coast and valleys. Shadows are easily detected in this photograph.